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E. Rutkowski

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Implementation of the United States/Russian HEU Agreement: Current Status and Prospects

Edward Mastal, Janie Benton and Joseph Glaser

U.S. Department of Energy, National Nuclear Security Administration

Ed Rutkowski

Lawrence Livermore National Laboratory

ABSTRACT

During Calendar Year (CY) 2002, the Russian Federation (R.F.) delivered low enriched uranium (LEU) from the conversion and processing of 30 metric tons (MT) of weapons-grade (90% ^{235}U assay) uranium. Through July 2003, the Highly Enriched Uranium (HEU) Transparency Implementation Program (TIP) will have monitored the conversion of over 190 MT HEU into LEU. This total represents about 38 percent of the projected 500 MT HEU scheduled to be blended down through the year 2013 and is equivalent to the destruction of 7,600 nuclear devices.

The National Nuclear Security Administration's (NNSA) HEU-TIP monitors the processing of this HEU at four Russian uranium-processing plants. During CY 2002, United States (U.S.) personnel monitored this process for a total of 194 monitor-weeks by staffing a Transparency Monitoring Office (TMO) located in Novouralsk, and through a series of five-day Special Monitoring Visits (SMV) to the four plants. U.S. monitor observations include the inventory of in-process containers, the observation of operations and non-destructive assay measurements (NDA) to determine ^{235}U enrichment, as well as the examination and validation of Russian Material Control and Accountability (MC&A) documents. In addition, the U.S. designed Blend Down Monitoring System (BDMS) installed at the Ural Electrochemical Integrated Plant (UEIP) in January 1999 monitored all HEU blended at that facility, which is about 50 percent of the HEU blended into LEU during CY 2002. Recently we installed a BDMS at the Electrochemical Plant (ECP) in Zelenogorsk and plans are underway to install a BDMS at the Siberian Chemical Enterprise (SChE) in Seversk in late 2004.

On a very positive note, interpersonal interactions between U.S. and Russian technical experts continues to expand and have proven to be an important element of the transparency regime. On the tenth anniversary¹ of the HEU Purchase Agreement², the Ministry of the R.F. for Atomic Energy (Minatom) also saluted the successful implementation of the government-to-government program as "an example of the effective realization of bilateral cooperation in real disarmament."

This paper describes the Program's monitoring efforts and achievements at the four Russian uranium processing plants, and will touch upon the issues of transparency and the natural uranium component activities.

BACKGROUND

In February 1993, the Governments of the United States and the Russian Federation signed a bilateral HEU Purchase Agreement for the purchase of LEU derived from 500 MT HEU removed from Russian nuclear weapons. The conversion of HEU to LEU is accomplished by four R.F. nuclear processing facilities: ECP, the Mayak Production Association (MPA), SChE, and UEIP. The LEU is then delivered to the United States where it is converted into fuel for use in commercial nuclear power plants. Through February 2002, all LEU deliveries went to the Portsmouth uranium

enrichment plant in Ohio. As enrichment operations at Portsmouth were shutdown, LEU deliveries after February 2002 went to the Paducah uranium enrichment plant in Kentucky. Five commercial power reactor fuel fabricators that process LEU in the United States are also subject to the HEU Purchase Agreement. This includes: Global Nuclear Fuel - Americas, Framatome-Lynchburg, Framatome-Richland, Westinghouse Fuel Fabrication Facility, and Westinghouse-Hematite (shutdown operations in 2001).

The NNSA (within the U.S. Department of Energy), U.S. Department of State (DOS), and Minatom are responsible for negotiating and implementing monitoring rights to meet transparency objectives. These rights assist the United States and the Russian Federation in assuring that the LEU delivered to the United States is blended from HEU removed from Russian nuclear weapons and that the LEU is used for peaceful purposes. Personnel (called “monitors”) from both countries exercise these rights during visits to a processing facility and observe operations to validate the MC&A data. In this fashion, the processing of HEU to LEU and its fabrication into reactor fuel is made “transparent.”

The transparency objectives specified in the HEU Purchase Agreement and the Memorandum of Understanding³ that need to be fulfilled are: (1) that the HEU subject to the Agreement is extracted from nuclear weapons, (2) that this same HEU enters the oxidation facility and is oxidized therein, (3) that the declared quantity of HEU is blended down into LEU, and (4) that the LEU delivered to the United States of America pursuant to the Agreement is fabricated into fuel for commercial nuclear reactors.

INTRODUCTION

The year 2002 proved to be a busy, challenging, and productive year for the HEU-TIP. The Program focused its monitoring efforts on: (1) conducting 20 SMV trips to the four Russian uranium-processing plants; (2) staffing the TMO at UEIP for almost eight months; (3) verifying the ²³⁵U enrichment content of HEU process and shipping containers; (4) observing and inventorying HEU containers declared by the Russian plants to contain HEU weapon components, chips, purified oxide, and uranium hexafluoride (UF₆); (5) improving the capability of our portable NDA equipment; (6) monitoring HEU blending operations with the U.S. BDMS installed at UEIP; (7) receiving, archiving and processing thousands of pages of Russian facility MC&A records; and (8) providing Minatom with records that track the LEU received from Russia into reactor fuel elements in the United States.

In addition, preparations were completed to install a BDMS at the ECP in Zelenogorsk. This system was installed and began operation in March 2003. We are pleased to announce that it continues to operate successfully and provides valuable monitoring data. Negotiations are currently underway to install and begin operation a BDMS at the SChE in Seversk.

In July 2002, the HEU-TIP completed its second inventory verification of the natural uranium returned to Russia under the March 1999 Natural Uranium Feed Component (NUFC) Agreement⁴. This is natural uranium that the United States Enrichment Corporation (USEC) receives from its customers and is equivalent to the feed component in the Russian LEU shipped to USEC. Our inventory of this material at UEIP ensures that the provisions of the Agreement are being observed. Monitors will conduct the third inventory verification in August 2003.

Both U.S. and R.F. monitors, and their respective managers, are to be commended for all their hard work and support given to this Program. Together our countries have over 160 active monitors available to support transparency efforts. This is in addition to their working full time jobs. Our monitors work diligently to inventory in-process containers, observe operations, perform NDA testing to determine ^{235}U enrichment, as well as the examination of MC&A documents. We are also very pleased with the personal interactions between the U.S. and R.F. technical experts. These interactions continue to be professional and have proven to be an important element of the transparency regime.

CURRENT STATUS

HEU Conversion

In CY 2002, Minatom blended about 30 MT of weapons-grade HEU into about 880 MT LEU that was delivered to USEC in St. Petersburg, Russia. The blended HEU is equivalent to about 1,200 nuclear devices. Minatom is expected to continue blending 30 MT HEU annually until 2013 when the entire contracted amount of 500 MT HEU will have been converted and about 15,000 MT LEU delivered to the United States. Through July 2003, Minatom is expected to deliver about 5,600 MT LEU blended down from about 190 MT of HEU, about 38 percent of the agreed total and equivalent to 7,600 nuclear devices.

Transparency Monitoring

The HEU-TIP experts monitor four Russian facilities through a series of SMV trips and the TMO at UEIP. Monitor activities include the inventory of in-process containers, observing HEU process operations, the receipt and analysis of MP&C data, and conducting NDA measurements on HEU containers to determine ^{235}U enrichment. In 2002, monitors made over 22,000 inventory observations.

Ten TMO monitors (two at a time) had daily access to the plant and monitored the processing of HEU for 58 monitor-weeks. In addition, TMO monitors also participate in SMV trips at UEIP and to other sites. The TMO celebrated its sixth anniversary with monitors having completed over 100 TMO assignments. Overall, the TMO has been staffed about 80 percent of the time (accounting for U.S. and R.F. holidays and travel) since opening in August 1996.

HEU-TIP monitors also conducted a total of 20 SMV trips to all four Russian facilities that process HEU into LEU under the HEU Purchase Agreement. During SMV trips, monitors were onsite for 136 monitor-weeks observing and recording information on Russian HEU processing. Monitors also receive copies of the BDMS output reports at ECP and UEIP for return to the United States for analysis. These reports provide continuous coverage of the HEU blending operation. As of December 2002, the Program has conducted 114 SMV trips and monitored the equivalent of 15 monitor-years at the four Russian facilities.

SMV monitoring provides first-hand information on the validity and completeness of MC&A data received from the plants. The MC&A data gathered by monitors indicates the Russian plant-to-plant material movements for production of LEU delivered in 2002. The data that is gathered on material processing rates and material container inventories in storage areas are also compared with Russian declared processing rates and material inventories. Analysis of this data allows HEU-TIP to gain confidence in the processing operations and provides information to direct future monitoring toward expected plant activities. HEU-TIP monitors observed more than 20 percent of all HEU containers for weapon components, chips, purified oxide, and UF_6 . These observations are an essential factor to establish assurance that transparency objectives are being achieved.

The R.F. uranium processing plants reached an annual blending level of 30 MT HEU in CY 2000. We expect the plants will continue to process at this level until all 500 MT HEU are blended down into LEU. By the end of 2003, we expect over 200 MT HEU (equivalent to 8,000 nuclear devices) to be blended into 5,900 MT LEU.

Over the next ten years we will strive to conduct up to 24 SMV trips annually to the R.F. plants, maintain the TMO at UEIP, and operate the BDMS equipment at all blending sites. Future HEU-TIP efforts in the Russian Federation are aimed towards strengthening transparency measures in a cost-effective and unobtrusive manner. In doing so, the Program expects to provide additional information to provide confidence that the HEU that is blended into LEU originated from weapons components. In addition, the Program will continue to work with our Russian counterparts to develop techniques that minimize interference on plant operations.

NDA Equipment

Portable sodium iodide NDA equipment (supplied by the United States) is used at each R.F. plant. This equipment provides direct and independent measurement of the uranium's enrichment level to assure that weapons-grade (90% ²³⁵U assay) HEU is being used in the Russian processing operations. R.F. plant technicians under U.S. monitor oversight perform NDA measurements on HEU metal, oxide and UF₆ containers.

We are currently replacing the original NDA instrumentation with updated equipment. While the current instrumentation has worked well since its first introduction in January 1997, the new units employ the AMPTEK GAMMA-X system, are more portable, provide enhanced reliability, and longer battery life. The units are at two plants and will be in place at all four plants and operational by mid-2004.

BDMS Equipment

Measurement of the enrichment, flow rate, and the tracing of HEU to LEU during the blending operation is a key element in determining that Russian weapons-grade HEU is being blended into LEU. The U.S. supplied BDMS equipment is designed to continuously and independently monitor these elements. During CY 2002, the BDMS monitored all HEU that was blended down at UEIP and the printed BDMS data reports were returned to the United States by SMV teams.

The availability of the system during the year was 90 percent and it provided excellent confirmation of the declared blending. The replacement of both the Cobalt-57 and Californium-252 sources was accomplished during a two-week period in early August. This is a necessary operation to maintain the instruments at their full operational capability.

Preparations for the installation of BDMS equipment at ECP were completed during CY 2002. The equipment was tested and shipped, a joint inventory with ECP personnel was performed at the plant, and the equipment underwent the required 30-day security review by ECP. The signing of a revised Annex 15 in November 2002 allowed the BDMS to be installed at ECP in February/March 2003. It continues to operate successfully and is providing valuable monitoring data. The operation of BDMS at ECP and UEIP gives HEU-TIP the ability to monitor over 70 percent of all HEU being down blended under the HEU Purchase Agreement.

Negotiations are currently underway to install BDMS equipment at SChE in Seversk. Discussions on the design and installation of similar equipment tailored to SChE were started in December 2002. We expect to have the BDMS installation operations begin in 2003, and have the equipment

delivered and operating by late 2004. Full certification of operations is expected to be completed by early 2005. At that time we will have the capability to monitor 100 percent of all HEU being down blended at the three plants.

We believe that the BDMS has proved itself to be an efficient and effective transparency tool to continuously monitor the HEU blending process at UEIP and ECP. We have learned many lessons in the process of negotiating for and in the installation of the BDMS at these sites, and we will use these lessons to improve the reliability and operability of existing units as well as our final BDMS installation. It is our view that various technological solutions will offer the best hope of balancing transparency access without adversely impacting plant operations.

Data Analysis

HEU-TIP maintains a secure computer database and communication system among 14 U.S. sites that support the Program. This allows the Program to centralize and better manage monitoring activities and R.F. material processing information. The more than eight years of data accumulation and analysis provides the quantitative information necessary to assess the extent that nonproliferation objectives are being achieved.

As part of the monitoring agreements, HEU-TIP monitors have access to and copy MC&A records at the R.F. plants. Some of the records are hand copied by the monitors at the plants and carried to the United States at the end of a monitoring visit. Other records are photocopied for future data exchanges between the Russian Federation and the United States. Virtually all of these records are transcribed and stored in a permanent, accessible database for further data analysis and information retrieval. U.S. technical experts review the data and prepare a report on each facility.

During CY2002, we fully implemented a data access and analysis system that utilizes a relational database and custom search engines to help perform the more routine data analysis tasks. This system is accessible to all participating sites within the program and has greatly improved the efficiency and capability of the program data analysts.

Uranium Feed Component Returned to Russia

Under the terms of the NUFC Agreement, signed March 24, 1999, DOE has the right to conduct one annual inventory of cylinders that contain the natural uranium feed component returned to Minatom. Delivery of this natural uranium to UEIP started in July 2000. On April 29, 2002, as per the Agreement, Minatom provided DOE with a report on the transfer of the natural uranium component in 2001 and an inventory of the natural uranium stored at UEIP on December 31, 2001. In the report, Minatom declared cylinders containing the natural uranium were in storage at UEIP.

During the week of July 15, 2002, a HEU-TIP feed monitoring team conducted a visit to the storage yard at UEIP to check the serial numbers of these cylinders and compare them with the numbers declared by Minatom. The team members verified that the cylinders declared by Minatom to contain the natural uranium were in storage at UEIP.

Pathfinder Responsibility

With almost ten years of experience in developing and implementing in-plant transparency measures, the HEU-TIP has attained a unique leadership role. With the experience and expertise derived from this accomplishment, HEU-TIP provides leadership to other U.S. Government programs involved in transparency measures and their interaction with R.F. nuclear material

processing facilities. HEU-TIP continues to provide support and coordination to these programs through such activities as inter-program discussions, as well as providing health and safety plans and procedures.

Russian Monitors to Visit U.S. Facilities

We look forward to September 2003, when the Russia Federation will initiate its fourth SMV in the United States (the last visit was October 2000). HEU-TIP will coordinate and accompany the R.F. monitoring team visits to three U.S. facilities. The team will conduct its first orientation visit to the Paducah uranium enrichment plant and will visit two nuclear fuel fabrication plants: the Framatome-Lynchburg facility in Lynchburg, Virginia, and the Westinghouse Fuel Fabrication Facility in Columbia, South Carolina. During this time the Russian monitors will have the opportunity to inventory cylinders and canisters containing LEU shipped from the R.F. processing plants, view the process as allowed under the Agreement, and review inventory forms. This complements the shipment of U.S. MC&A data to Russia by the HEU-TIP.

HEU-TIP also maintains office space for R.F. monitors that is comparable to the U.S. TMO in Russia. In addition, the Program will assist the visited U.S. facilities to assure that the necessary transparency activities are provided.

CONCLUSION

HEU-TIP is a robust and mature program supported by five DOE operation offices and seven major DOE laboratories. We are proud of what we have achieved over the past ten years and we will continue to strive for more cost-effective and unobtrusive monitoring coupled with more efficient and effective analyses. Our Program's success is the direct result of and testament to the dedication, professionalism, and technical expertise of each and every member of the transparency program in Russia and the United States

Cooperation between the United States and the Russian Federation in joint transparency activities has resulted in the unprecedented success that supports the nonproliferation objectives of the HEU Purchase Agreement. We believe that our continued cooperation and mutual respect will enable us to translate innovation and ideas into practical applications in the remaining years of operations.

¹ The HEU-LEU Agreement in Retrospect: Ten Years of Cooperation Between DOE and Minatom, Kurt Siemon, Edward Mastal, U.S. Department of Energy; Alexander Kashirsky, Vladimir Yevseyenko, Ministry of the Russian Federation for Atomic Energy. (INMM 44th Annual Meeting, July 16, 2003)

² Agreement between the Government of the United States of America and the Government of the Russian Federation concerning the disposition of highly enriched uranium extracted from nuclear weapons. (February 1993)

³ Memorandum of Understanding between the government of the United States of America and the government of the Russian Federation relating to transparency and additional arrangements concerning the Agreement between the Government of the United States of America and Government of the Russian Federation concerning the disposition of highly enriched uranium extracted from nuclear weapons. (September 1993)

⁴ Agreement between the United States Department of Energy and the Ministry of the Russian Federation for Atomic Energy concerning the transfer of source material to the Russian Federation. (March 1999)

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